

IN THE CLAIMS:

1. (previously presented) A quartz crystal tuning fork resonator capable of vibrating in a flexural mode, the quartz crystal tuning fork resonator comprising:

a plurality of quartz crystal tuning fork tines for undergoing vibration in an inverse phase, each of the quartz crystal tuning fork tines having a first main surface and a second main surface opposite the first main surface, each of the first and second main surfaces having a central linear portion;

a quartz crystal tuning fork base to which the quartz crystal tuning fork tines are attached; and

at least one groove formed in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines, a width of the groove in the central linear portion of one of the first and second main surfaces of each of the quartz crystal tuning fork tines being greater than or equal to a distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine.

2. - 9. (canceled).

10. (currently amended) A quartz crystal tuning fork resonator capable of vibrating in a flexural mode, the quartz crystal tuning ~~fork~~ fork resonator comprising:

a plurality of quartz crystal tuning fork tines each having a plurality of stepped portions;

a quartz crystal tuning fork base to which the quartz crystal tuning fork tines are attached;

at least one first electrode disposed on each of two of the stepped portions of each of the quartz crystal tuning fork tines; and

at least one second electrode disposed on a side of each of the quartz crystal tuning fork tines, the second electrode of each of the quartz crystal tuning fork tines having an electrical polarity opposite to an electrical polarity of the first electrode of each of the quartz crystal tuning fork tines.

11. - 26. (canceled).

27. (previously presented) An integrated quartz crystal tuning fork resonator for undergoing vibration in a flexural mode, the integrated quartz crystal tuning fork comprising:

a plurality of individual quartz crystal tuning fork resonators each capable of vibrating in a flexural mode, the plurality of individual quartz crystal tuning fork resonators being selected from the group consisting of:

(A) a quartz crystal tuning fork resonator having a plurality of quartz crystal tuning fork tines each having sides and a central linear portion, a quartz crystal tuning fork base to which the quartz crystal tuning fork tines are attached, at least one groove formed in the central linear portion of each of the quartz crystal tuning fork tines, at least one first electrode disposed in the at least one groove of each of the quartz crystal tuning fork tines, and at least one second electrode disposed on a side of each of the quartz crystal tuning fork tines, the second electrode of each of the quartz crystal tuning fork tines having an electrical polarity opposite to an electrical polarity of the first electrode of each of the quartz crystal tuning fork tines;

(B) a quartz crystal tuning fork resonator having a plurality of quartz crystal tuning fork tines, a quartz crystal tuning fork base to which the quartz crystal tuning fork tines are attached, a plurality of grooves formed in the quartz crystal tuning fork base, and at least one electrode disposed in each of the grooves;

(C) a quartz crystal tuning fork resonator having a plurality of quartz crystal tuning fork tines each having a plurality of stepped portions, a quartz crystal tuning fork base to which the quartz crystal tuning fork tines are attached, at least one first electrode disposed on each of two of the stepped portions of each of the quartz crystal tuning

fork tines portions, at least one second electrode disposed on a side of each of the quartz crystal tuning fork tines, the second electrode of each of the quartz crystal tuning fork tines having an electrical polarity opposite to an electrical polarity of the first electrode of each of the quartz crystal tuning fork tines; and

(D) a combination of individual resonators according to at least two of (A), (B) and (C).

28. - 38. (canceled).

39. (previously presented) A quartz crystal tuning fork resonator according to claim 1; wherein the plurality of quartz crystal tuning fork tines comprises a first quartz crystal tuning fork tine and a second quartz crystal tuning fork tine; and wherein the grooves in the first and second main surfaces of each of the first and second quartz crystal tuning fork tines are disposed opposite each other in a thickness direction of the first and second quartz crystal tuning fork tines.

40. (previously presented) A quartz crystal tuning fork resonator according to claim 39; wherein each of the first and second quartz crystal tuning fork tines has side surfaces; and further comprising a plurality of first electrodes each disposed in a respective groove of the first and second quartz crystal tuning fork tines, and a plurality

of second electrodes each disposed on a respective side surface of each of the first and second quartz crystal tuning fork tines, the second electrodes of each of the first and second quartz crystal tuning fork tines having an electrical polarity opposite to an electrical polarity of the first electrodes of each of the quartz crystal tuning fork tines.

41. (previously presented) A quartz crystal tuning fork resonator according to claim 40; wherein the first electrode disposed in one of the grooves of the first quartz crystal tuning fork tine is connected to the second electrode disposed on one of the side surfaces of the second quartz crystal tuning fork tine such that the first electrode of the first quartz crystal tuning fork tine and the second electrode of the second quartz crystal tuning fork tine define a first electrode terminal; and wherein the second electrode disposed on one of the side surfaces of the first quartz crystal tuning fork tine is connected to the first electrode disposed in one of the grooves of the second quartz crystal tuning fork tine such that the second electrode of the first quartz crystal tuning fork tine and the first electrode of the second quartz crystal tuning fork tine define a second electrode terminal.

42. (previously presented) A quartz crystal tuning fork resonator according to claim 41; wherein two of the side surfaces of each of the first and second quartz crystal tuning

fork tines comprises an inner side surface and an outer side surface opposite the inner side surface; wherein when a direct current voltage is applied between the first and second electrode terminals, a direction of an inner electric field generated between the second electrode disposed on the inner side of the first quartz crystal tuning fork tine and the first electrode disposed in one of the grooves opposite to the second electrode disposed on the inner side of the first quartz crystal tuning fork tine is the same as a direction of an inner electric field generated between the second electrode disposed on the inner side of the second quartz crystal tuning fork tine and the first electrode disposed in one of the grooves opposite to the second electrode disposed on the inner side of the second quartz crystal tuning fork tine, and a direction of an outer electric field generated between a second electrode disposed on the outer side of the first tuning quartz crystal fork tine and the first electrode disposed in one of the grooves opposite to the second electrode disposed on the outer side of the first quartz crystal tuning fork tine is the same as a direction of an outer electric field generated between the second electrode disposed on the outer side of the second quartz crystal tuning fork tine and the first electrode disposed in one of the grooves opposite to the second electrode disposed on the outer side of the second quartz crystal tuning fork tine, the

direction of each of the inner electric fields being opposite to the direction of each of the outer electric fields.

43. (previously presented) A quartz crystal tuning fork resonator according to claim 42; wherein the directions of the inner and outer electric fields of the first and second quartz crystal tuning fork tines are generally along an x-axis direction of the quartz crystal tuning form resonator.

44. (previously presented) A quartz crystal tuning fork resonator according to claim 43; wherein no electric field is generated between first electrodes disposed in opposite grooves of the first and second quartz crystal tuning fork tines when the direct current voltage is applied between the first and second electrode terminals.

45. (previously presented) A quartz crystal tuning fork resonator according to claim 44; wherein the inner and outer sides of the first and second quartz crystal tuning fork tines undergo simultaneous deformation in opposite directions along a longitudinal axis of the first and second quartz crystal tuning fork tines.

46. (previously presented) A quartz crystal tuning fork resonator according to claim 45; wherein when an alternating current voltage is applied between the first and

second electrode terminals, the first and second quartz crystal tuning fork undergo vibration in a flexural mode of an inverse phase.

47. (previously presented) A quartz crystal tuning fork resonator according to claim 10; wherein the quartz crystal tuning fork tines comprise first and second quartz crystal tuning fork tines each having a first main surface and a second main surface opposite the first main surface, each of the first and second main surfaces having one of the two stepped portions; wherein the first electrodes disposed in the two stepped portions of the first quartz crystal tuning fork tine are connected to the second electrode disposed on the side of the second quartz crystal tuning fork tine to define a first electrode terminal; and wherein the second electrode disposed on the side of the first quartz crystal tuning fork tine is connected to the first electrodes disposed in the two stepped portions of the second quartz crystal tuning fork tine to define a second electrode terminal.

48. (previously presented) A quartz crystal tuning fork resonator according to claim 47; wherein each of the first and second main surfaces of each of the first and second quartz crystal tuning fork tines has a central linear portion; and wherein the two stepped portions corresponding to the

first and second main surfaces of each of the first and second quartz crystal tuning fork tines are disposed on opposite sides of the central linear portion.

49. (previously presented) A quartz crystal tuning fork resonator according to claim 48; wherein when an alternating current voltage is applied between the first and second electrode terminals, the first and second quartz crystal tuning fork undergo vibration in a flexural mode of an inverse phase.

50. (previously presented) A quartz crystal tuning fork resonator according to claim 27; wherein each of the plurality of individual resonators is connected to at least one other individual resonator of the plurality of resonators through a base portion.

51. (previously presented) A quartz crystal tuning fork resonator according to claim 27; wherein each of the individual quartz crystal tuning fork resonators differs from another of the individual quartz crystal tuning fork resonators at least in one of the shape thereof and the configuration of the electrodes.

52. (previously presented) A quartz crystal tuning fork resonator according to claim 27; wherein the individual quartz crystal tuning fork resonators are electrically connected together in parallel.

53. (previously presented) A quartz crystal tuning fork resonator comprising:

a quartz crystal tuning fork base;

a plurality of quartz crystal tuning fork tines extending from the quartz crystal tuning fork base so that portions of the quartz crystal tuning fork base and portions of the quartz crystal tuning fork tines define opposite first and second main surfaces of the quartz crystal tuning fork resonator;

a first set of grooves formed in the first and second main surfaces of the quartz crystal tuning fork resonator;

a second set of grooves formed in the first and second main surfaces of the quartz crystal tuning fork resonator; and

a third set of grooves formed in the first and second main surfaces of the quartz crystal tuning fork resonator and between the first and second set of grooves.

54. (previously presented) A quartz crystal tuning fork resonator according to claim 53; further comprising a first set of electrodes having the same polarity and each disposed in a respective one of the first set of grooves; and a second set of electrodes having the same polarity and each disposed in a respective one of the second set of grooves.

55. (previously presented) A quartz crystal tuning fork resonator according to claim 54; wherein the polarity of the first set of electrodes is different from the polarity of the second set of electrodes.

56. (previously presented) A quartz crystal tuning fork resonator according to claim 54; wherein the third set of grooves comprises a first pair of intermediate grooves each formed on a respective one of the first and second main surfaces and a second a second pair of intermediate grooves each formed on a respective one of the first and second main surfaces.

57. (previously presented) A quartz crystal tuning fork resonator according to claim 56; further comprising a third set of electrodes having the same polarity and each disposed in a respective one of the first pair of intermediate grooves; and a fourth set of electrodes having the same polarity and each disposed in a respective one of the second pair of intermediate grooves.

58. (previously presented) A quartz crystal tuning fork resonator according to claim 57; wherein portions of the quartz crystal tuning fork base and portions of the quartz crystal tuning fork tines define opposite first and second side surfaces of the quartz crystal tuning fork resonator; and further comprising a fifth electrode disposed on the first

side surface and a sixth electrode disposed on the second side surface and having a different polarity than the fifth electrode.

59. (previously presented) A quartz crystal tuning fork resonator according to claim 58; wherein the second and fourth sets of electrodes and the fifth electrode have the same polarity; and wherein the first and third sets of electrodes and the sixth electrode have the same polarity.

60. (previously presented) A quartz crystal tuning fork resonator according to claim 59; wherein the quartz crystal tuning fork resonator is symmetrical about a central plane thereof.